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Bruneau

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(54) **CENTRAL VACUUM SYSTEM WITH SECONDARY AIRFLOW PATH**

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A47L 9/22 (2006.01)

(52) **U.S. Cl.** **15/413**; 15/301

(58) **Field of Classification Search** 15/413, 15/301
See application file for complete search history.

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(57) **ABSTRACT**

A central vacuum system includes a motor-cooling airflow path that provides sufficient cooling for the motor and its drive components even though the cooling air is partially restricted by a downstream filter that captures airborne carbon dust emitted from the motor's commutator brushes. A divider system creates multiple chambers within the vacuum system's canister, and in some embodiments, air passageways in the canister and in the divider system direct the cooling air through the chambers in a flow pattern that avoids contaminating the drive components with carbon dust.

17 Claims, 5 Drawing Sheets

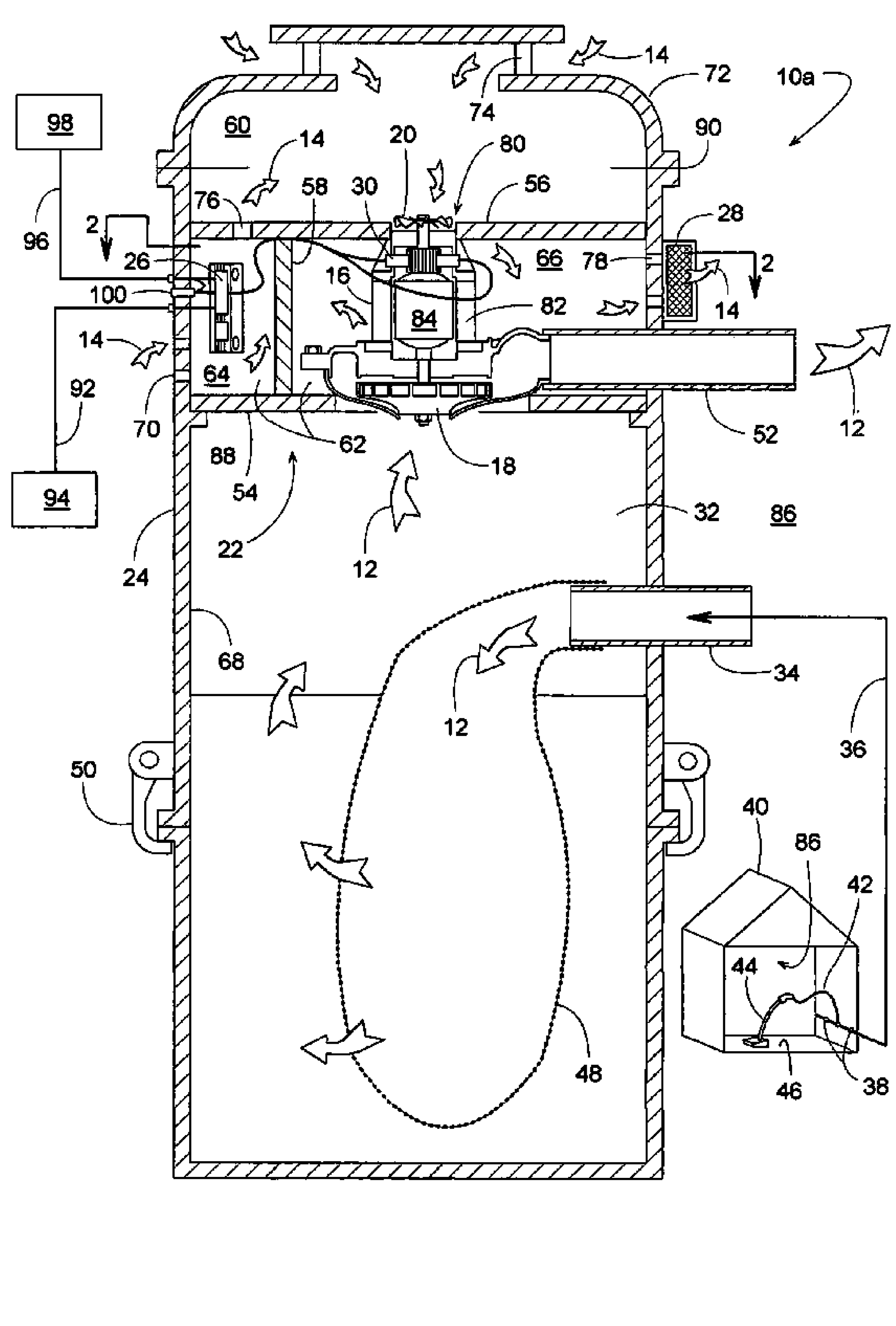

FIG. 1

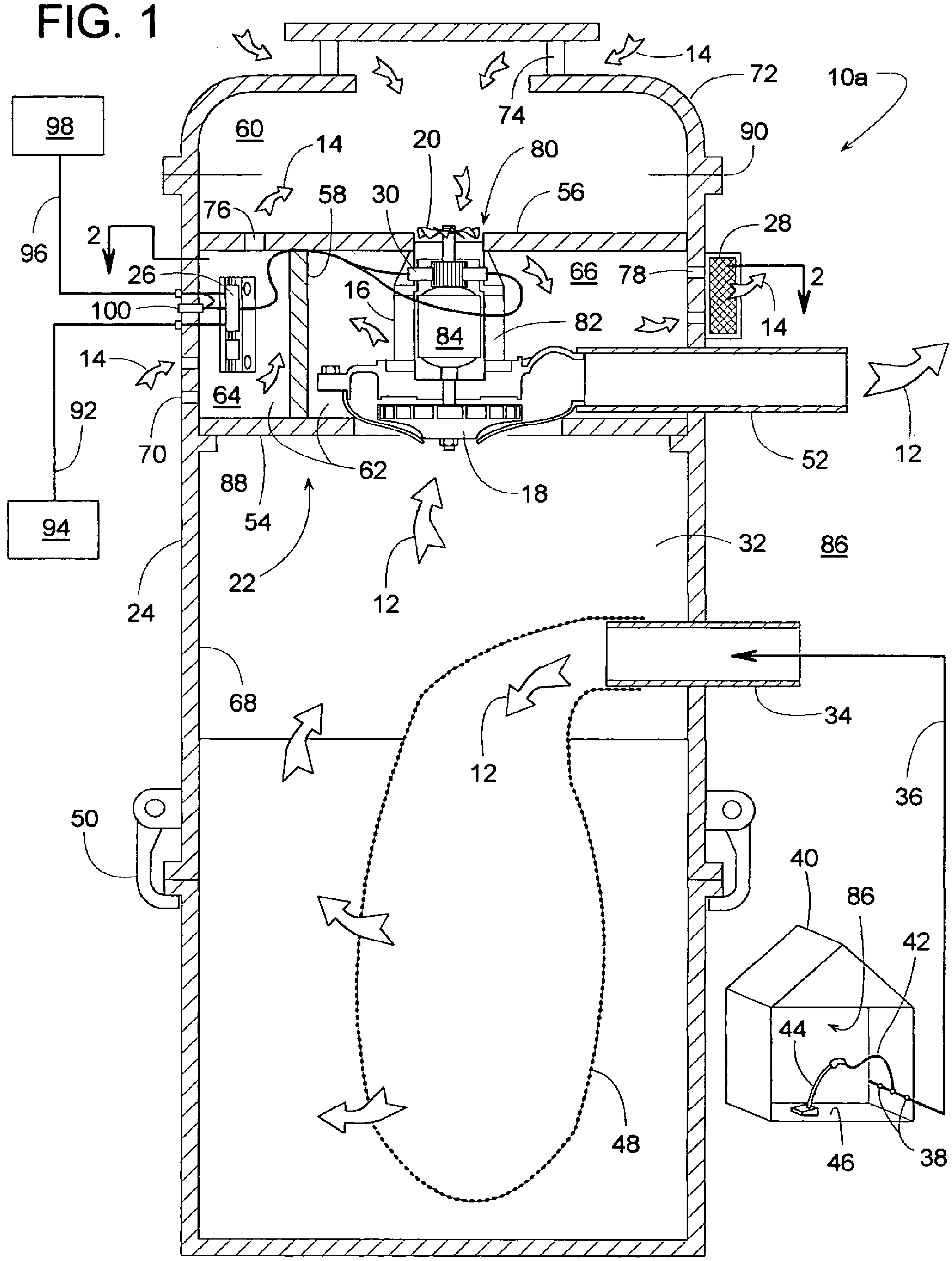
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FIG. 2

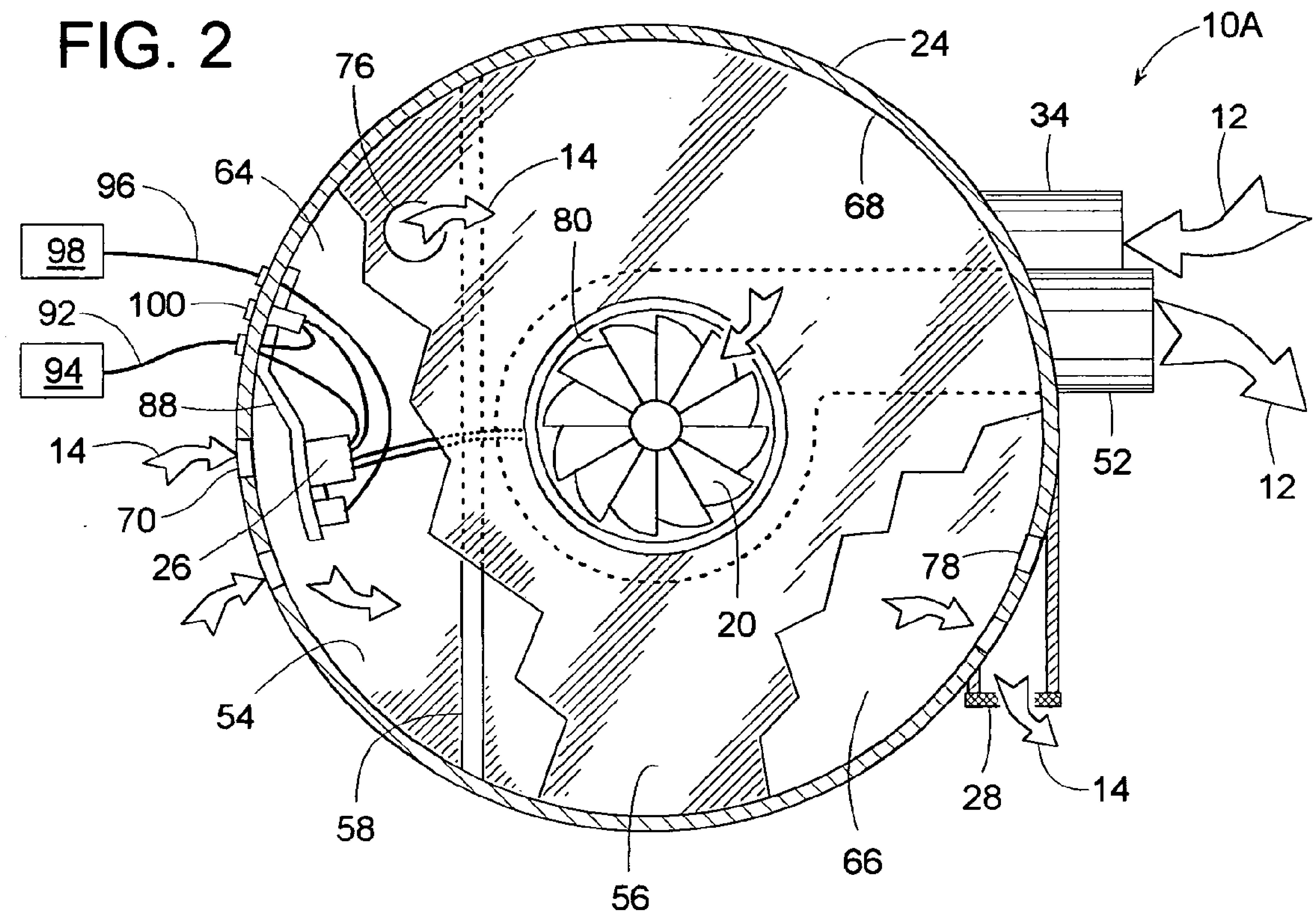
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FIG. 3

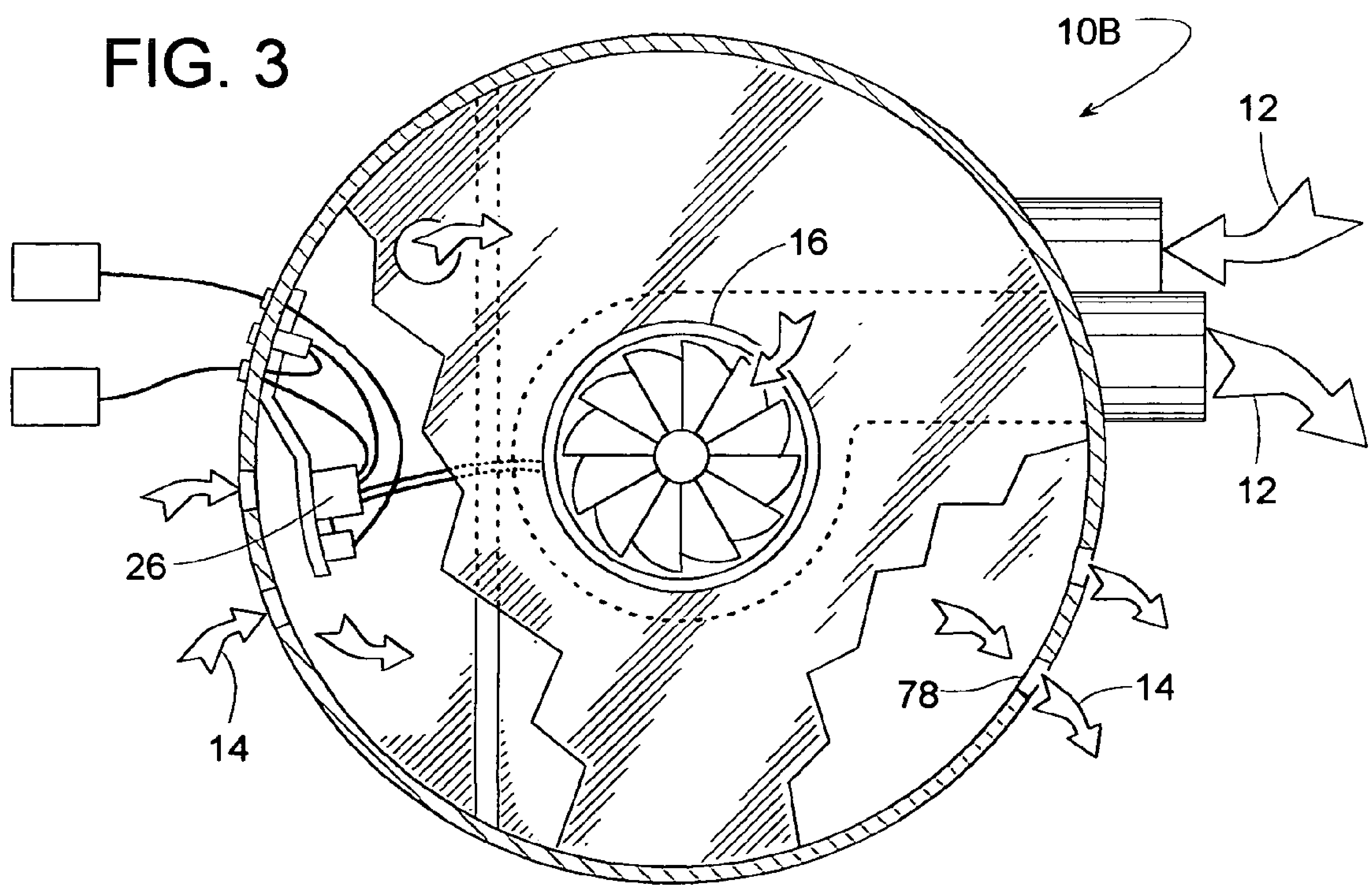
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FIG. 4

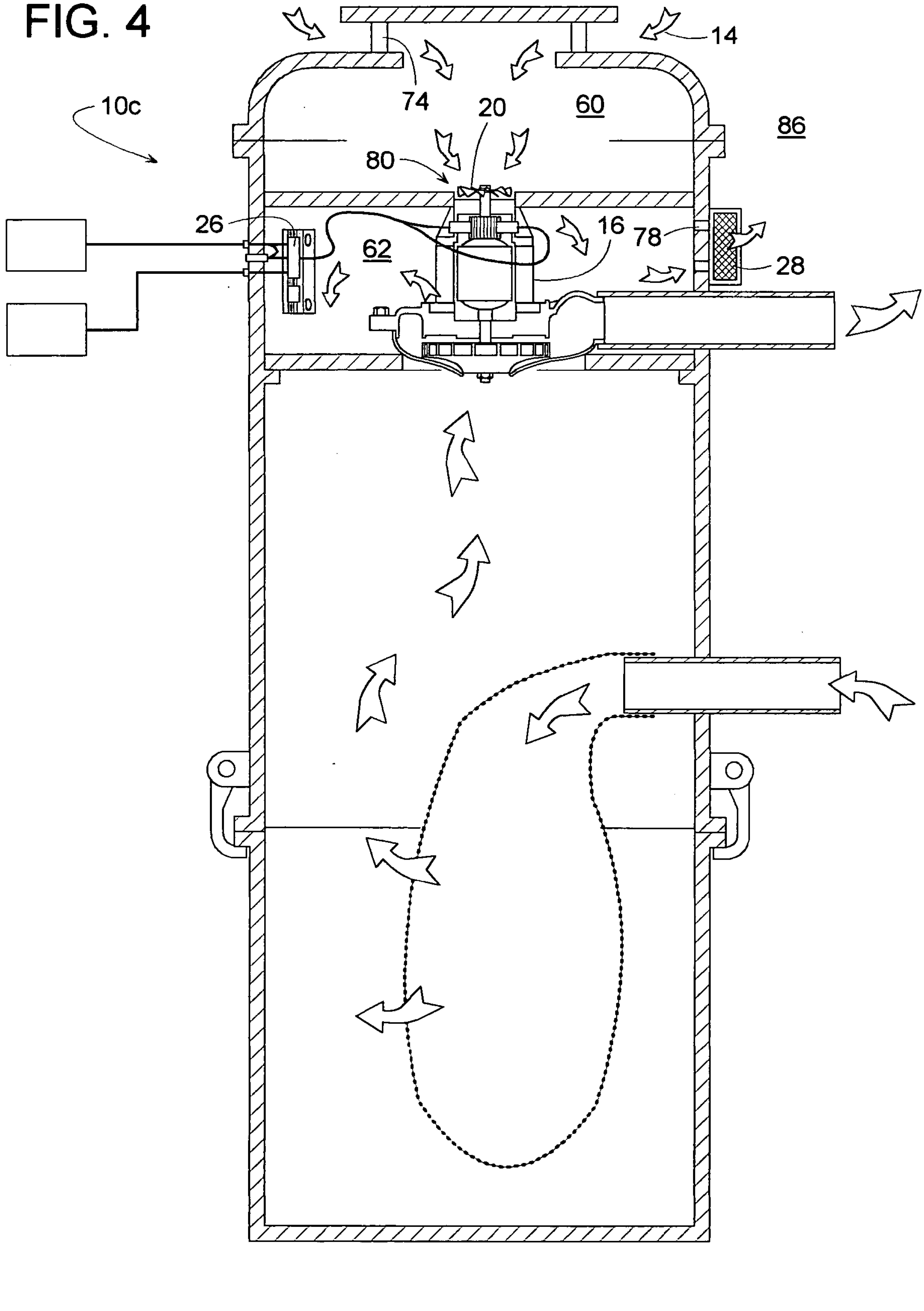


FIG. 5

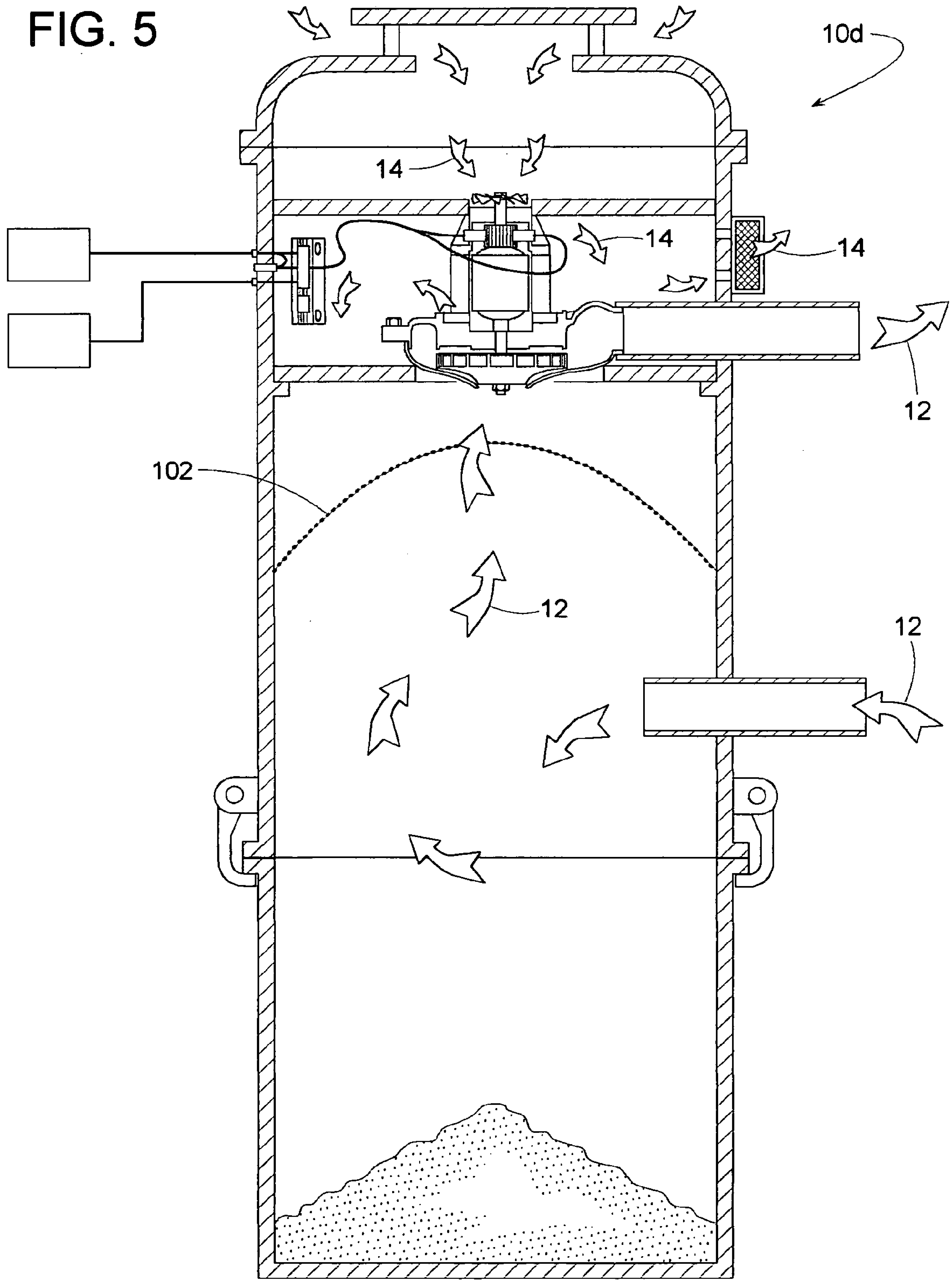
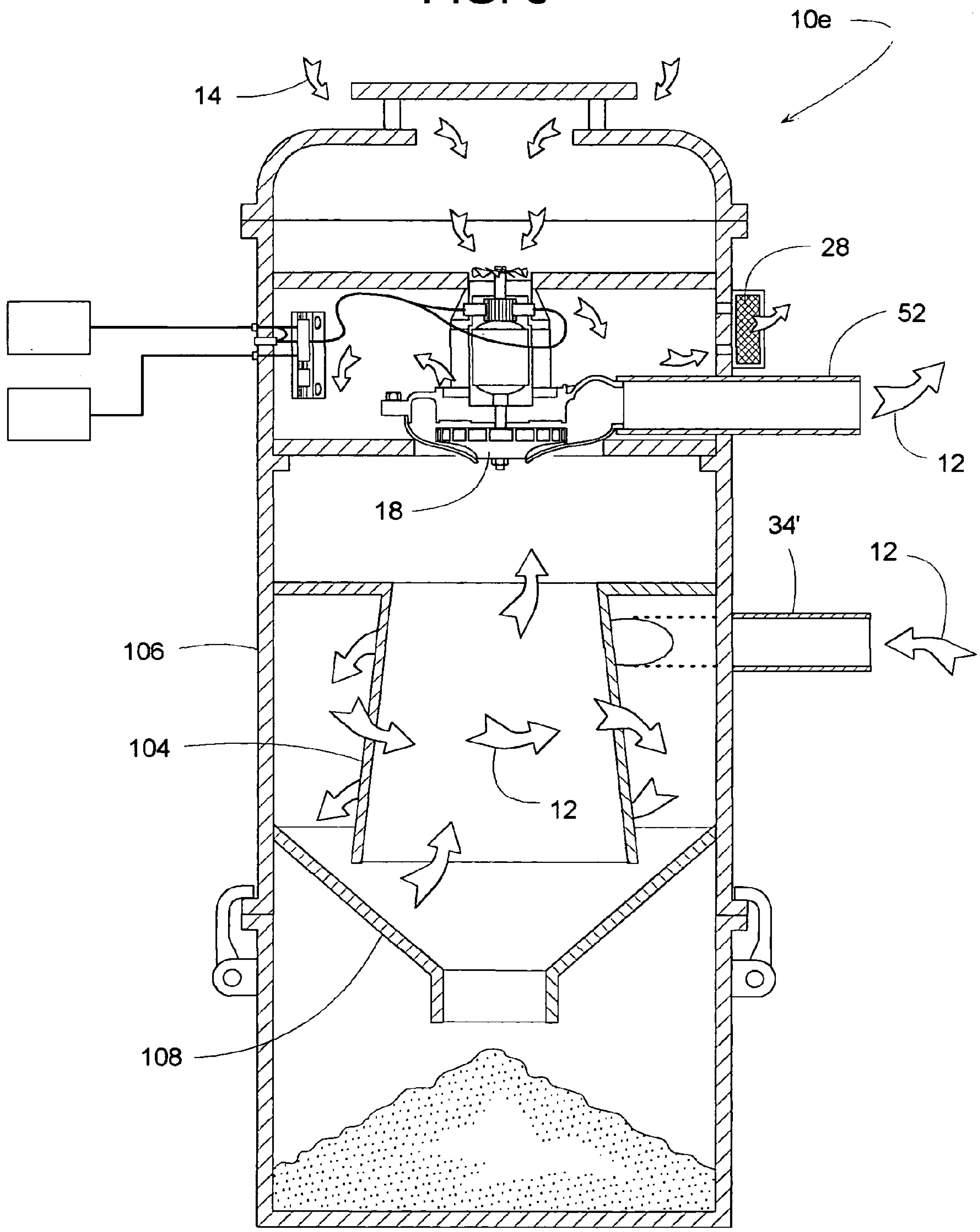


FIG. 6



CENTRAL VACUUM SYSTEM WITH SECONDARY AIRFLOW PATH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The subject invention generally pertains to central vacuum systems and more particularly to a motor-cooling airflow path for such a system.

2. Description of Related Art

Typical central vacuum systems comprise a blower or vacuum motor that creates a vacuum within a stationary canister. A network of tubing usually connects the canister to several wall-mounted inlet ports that are installed at various locations throughout a house or building. A flexible hose can connect a portable vacuum tool to any of the inlet ports, so the tool can be used for vacuuming a floor or other surface. The vacuum motor draws dust-laden air in series through the tool, through the hose, through the tubing network and into the canister where the dust collects. The canister can be manually opened to empty it periodically.

There are two main types of central vacuum system: cyclonic and filtered. With a cyclonic system, structure within the canister directs the dust-laden air to circulate in a vortex, which employs centrifugal force to help separate the heavier dust particles from the air. A chute directs the separated dust particles to the bottom of the canister where they accumulate for later disposal. The vacuum motor draws the lighter clean air out from within the center of the vortex and discharges the air to atmosphere. Some cyclonic vacuum systems also include a filter.

In comparison, a filtered system includes a main filter instead of the vortex-generating structure. The filter blocks the dust particles while allowing clean air to be discharged to atmosphere. If the filter is in the form of a bag, the dust collects in the bag. Otherwise, the dust may simply drop from the filter onto the bottom of the canister for later disposal.

Many vacuum cleaners direct air across its motor to help cool the motor. The cooling air, unfortunately, may entrain carbon dust from the motor's commutator brushes and deposit a carbon residue on the exterior of the machine. To avoid this problem, some vacuum cleaners have a separate filter to help keep the carbon dust inside the machine. Examples of vacuum cleaners with a filter for carbon dust are disclosed in U.S. Pat. Nos. 5,685,894 and 5,412,837. Although such filters help keep the machine clean, they also create an airflow restriction that may lead to overheating.

Consequently, there is a need for a vacuum cleaner having a cooling airflow pattern that is suitable for use with a carbon dust filter.

SUMMARY OF THE INVENTION

One object of some embodiments of the invention is to provide a central vacuum system with a filter for catching carbon dust released from the vacuum motor's commutator brushes.

Another object of some embodiments is to cool one or more of the motor's electrical drive components (e.g., a triac) with air that has not first been preheated by the motor.

Another object of some embodiments is to help prevent carbon dust from a motor's commutator brushes from contaminating a motor drive component or its associated circuit board.

Another object of some embodiments is to install a vacuum motor and its electrical drive components in two separate compartments within a tubular canister of a central vacuum system.

Another object of some embodiments is to cool a vacuum motor with a greater volume of air than that used for cooling the motor's electrical drive components.

Another object of some embodiments is to provide a central vacuum system with a filter for carbon dust without having to install the motor's drive components on the exterior of the vacuum canister.

Another object of some embodiments is to mount air-cooled electrical components within a vacuum canister and still provide a removable cover at the top of the canister for accessing the motor and other interior components.

Another object of some embodiments is to cool a vacuum motor's drive components with a relatively cool, low volume of air, and to cool the motor itself with warmer air but at a higher volume.

Another object of some embodiments is to provide a vacuum canister with a plenum for mixing ambient air with air that has been preheated by the motor's electrical drive components.

Another object of some embodiments is to maintain the absolute air pressure of various chambers within a vacuum canister to achieve a desired airflow pattern for cooling a motor and its electrical drive components.

Another object of some embodiments is to position a motor chamber and an electrical chamber between an upper plenum and a lower suction chamber to facilitate the assembly, repair and operation of a central vacuum system.

Another object of some embodiments is to install a motor's electrical components inside a central vacuum canister with the cylindrical sidewall of the canister supporting the weight of the components, thereby eliminating the need for an exterior mounted electrical box.

One or more of these and/or other objects of the invention are provided by a central vacuum canister that includes a motor-cooling airflow pattern that can accommodate a filter for catching carbon dust released from the motor's commutator brushes.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross-sectional side view of a vacuum canister and a schematic illustration of the remainder of a central vacuum system, wherein the canister includes a filter for capturing carbon dust from a current of air that cools the motor and its electrical drive components.

FIG. **2** a cross-sectional view taken generally along line **2-2** of FIG. **1**, wherein portions of a canister divider system are cutaway to show underlying detail. Also, vent holes are shown elevated from their true position to more clearly show their function.

FIG. **3** is similar to FIG. **2** but showing a different embodiment where the carbon dust filter is omitted.

FIG. **4** is similar to FIG. **1** but showing one of the dividers omitted.

FIG. **5** is similar to FIG. **4** but showing a vacuum system that includes a different type of main filter.

FIG. **6** is a cross-sectional view similar to FIG. **5** but showing yet another embodiment.

DESCRIPTION OF THE PREFERRED EMBODIMENT

FIGS. **1** and **2** show a vacuum system **10** that conveys primary air **12** for cleaning (larger arrows) and conveys secondary air **14** for cooling (smaller arrows). A motor **16** drives both a main impeller **18** for moving primary air **12** and a fan or secondary impeller **20** for moving cooling air **14**. A divider system **22** installed within a cylindrical or otherwise tubular canister **24** divides the canister into various chambers and directs secondary air **14** in a flow pattern suitable for cooling motor **16** and for cooling at least one motor drive component **26** (e.g., triac). The flow pattern is such that air **14** provides ample cooling even though the airflow is partially restricted by a secondary filter **28** that captures carbon dust emitted from the motor's commutator brushes **30**.

In operation, main impeller **18** draws air **12** from within a suction chamber **32** of canister **24**, which is installed at a generally fixed location. A suction inlet **34** connects suction chamber **32** to a network of tubing **36** that leads to several wall-mounted inlet ports **38** that are installed at various locations throughout a house or building **40**. A flexible hose **42** connects a portable vacuum tool **44** to any of the inlet ports **38** so that tool **44** can be used for vacuuming a floor **46** or other surfaces.

To clean a surface, motor-driven impeller **18** draws dust-laden air or some other fluid from ambient atmosphere **86** in series through tool **44**, through hose **42**, through tubing network **36**, through suction inlet **34**, and into suction chamber **32** where much of the dust and other contaminants collects within a filter bag or accumulates at the bottom of canister **24**. A main separator **48** installed between suction inlet **34** and main impeller **18** helps trap the contaminants within canister **24**. Although separator **48** is shown as a dust-collecting filter bag, other separator designs are well within the scope of the invention. A joint connector **50** enables canister **24** to be manually opened to change or clean separator **48** or to empty the canister periodically. In this example, the dust and air are separated by filtration and the dust is collected within a filter bag; however, other methods of separation and collection can be used.

After separating the dust from the air, main impeller **18** discharges cleaner air through a discharge outlet **52** that exhausts the air to ambient atmosphere **86**. The term, "ambient atmosphere" refers to any gas or other fluid outside canister **24**. Examples of ambient atmosphere include, but are not limited to, the air surrounding the canister's exterior, the air just upstream of suction inlet **34**, and the air within building **40**.

In some embodiments, in order to cool motor **16** and one or more of its drive components **26**, divider system **22** comprises a first divider **54**, a second divider **56** and a third divider **58**. First and second dividers **54** and **56** are generally round and extend diametrically across canister **24** to help define a plenum **60** at the upper end of canister **24**, suction chamber **32** at the bottom, and a heat-generating chamber **62** between chambers **32** and **60**. Third divider **58** extends between dividers **54** and **56** to separate heat-generating chamber **62** into an electrical chamber **64** and a motor chamber **66**. Motor **16** extends into motor chamber **66**, and one or more motor drive components **26** are disposed within electrical chamber **64**.

The term, "motor drive component" refers to any heat-generating electrical device that affects the motor's electrical power. Examples of a motor drive component include, but are not limited to, a triac, diac, power transistor, resistor, inverter, etc. Many such motor drive components are particularly suited for central vacuum systems where a variable speed motor drive is important for switching between heavy and light duty vacuuming (e.g., vacuuming floors vs. curtains).

To provide a path for cooling air **14** to circulate through electrical chamber **64**, motor chamber **66** and plenum **60**, a tubular sidewall **68** of canister **24** defines one or more electrical chamber inlets **70**, an upper end cap **72** defines a plenum inlet **74**, and second divider **56** defines an opening or electrical chamber outlet **76**. Tubular sidewall **68** also defines one or more motor chamber outlets **78** that lead to secondary filter **28**. In cases where third divider **58** is omitted, motor chamber outlet **78** can be referred to as a heat-generating chamber outlet because the heat-generating chamber would no longer be divided into two distinct chambers (i.e., no longer a motor chamber and an electrical chamber).

To cool motor **16** and component **26**, and to inhibit carbon dust from being discharged to atmosphere, secondary impeller **20** draws air **14** from plenum **60**, through a secondary impeller inlet **80**, and into motor chamber **66**. Impeller **20** forces air **14** across motor **16** where some of air **14** passes between the motor's stator **82** and rotor **84** and other portions of air **14** pass out over the top of stator **82** near the motor's commutator brushes **30**. After cooling motor **16**, air **14** travels from motor chamber **66**, through motor chamber outlet **78**, through secondary filter **28**, and out to ambient atmosphere **86**. Secondary filter **28** helps capture airborne carbon dust to ensure that air **14** being exhausted to atmosphere is sufficiently clean.

To supply plenum **60** with air, impeller **20** creates a negative pressure (below atmospheric pressure) within plenum **60**, which draws ambient air into plenum **60** through plenum inlet **74**. Electrical chamber outlet **76** allows the negative pressure in plenum **60** to also draw in **14** air that has been preheated by component **26** in electrical chamber **64**. Thus, plenum **60** receives a mixture of ambient air and preheated air, wherein secondary impeller inlet **80** delivers the mixture to motor chamber **66**.

To cool motor drive component **26**, the air entering plenum **60** through electrical chamber outlet **76** reduces the pressure within electrical chamber **64** such that ambient air is drawn into chamber **64** via electrical chamber inlet **70**. Thus, air **14** travels in series through electrical chamber inlet **70**, through electrical chamber **64** to cool component **26**, and out through electrical chamber outlet **76** to mix with ambient air in plenum **60**. A bracket **88** attached to sidewall **68** supports motor drive component **26** at a position where air **14** entering through electrical chamber inlet **70** can pass directly across and around component **26**.

The flow of air **14** through the upper portion of canister **24** is such that the motor chamber pressure is greater than the ambient atmosphere pressure, the ambient atmosphere pressure is greater than the electrical chamber pressure, the electrical chamber pressure is greater than the plenum pressure, and the plenum pressure is greater than the suction pressure in suction chamber **32**. The term, "pressure" pertains to absolute pressure rather than gage pressure, thus even air below atmospheric pressure (e.g., below 14.7 psi) can be considered to have a positive absolute pressure.

The electrical chamber inlet **70** enables component **26** to be cooled by relatively cool ambient air that is generally not preheated by motor **16**. Also, the influx of ambient air through plenum inlet **74** allows motor **16** to receive at least some fresh air that has not first passed across component **26**. Moreover, component **26** being upstream of motor **16** helps prevent the motor brush's carbon dust from contaminating component **26** or its associated circuit board.

Since electrical chamber **64** receives unheated ambient air through electrical chamber inlet **70**, and motor **16** receives a slightly warmer mixture of air, it may be desirable to have the flow rate of air **14** passing through motor chamber **66** be slightly greater than that passing through electrical chamber **64**, which in fact is the case with vacuum system **10**.

By locating electrical chamber **64** along the side of canister **24**, upper end cap **72** can be removed via a joint **90** without disturbing any electrical connections that feed into canister **24**. Examples of such electrical connections include, but are not limited to, a power cord **92** from a power supply **94** (e.g., wall outlet), control-wiring **96** from a control panel **98**, a fuse **100**, etc. In a currently preferred embodiment, the electrical connections are supported by the same bracket **88** that supports motor drive component **26**.

In another embodiment, shown in FIG. **3**, a vacuum system **10***b* is the same as vacuum system **10***a*; however, secondary filter **28** is omitted. Without filter **28**, motor chamber outlet **78** exhausts unfiltered air **14** directly to atmosphere. Although carbon dust may be released, removing filter **28** may increase the cooling of motor **16** and component **26**.

In another embodiment, shown in FIG. **4**, a vacuum system **10***c* is similar to vacuum system **10***a*; however, third divider **58**, electrical chamber inlet **70** and electrical chamber outlet **76** are omitted. Without third divider **58**, motor **16** and drive component **26** share the same space within heat-generating chamber **62**. In this case, secondary impeller **20** forces cooling air **14** to travel in series from ambient atmosphere **86**, through plenum inlet **74**, through plenum **60**, through secondary impeller inlet **80**, into heat-generating chamber **62** to cool motor **16** and component **26**, through heat-generating chamber outlet **78**, through secondary filter **28** to impede carbon dust, and back out to ambient atmosphere **86**.

In another embodiment, shown in FIG. **5**, a vacuum system **10***d* is the same as vacuum system **10***c*; however, main separator **48** (in the form of a bag) is replaced by another main filter **102** of a different shape. With filter **102**, dust collects at the bottom of the vacuum canister.

In another embodiment, shown in FIG. **6**, a vacuum system **10***e* is similar to systems **10***c* and **10***d*; however vacuum system **10***e* separates contaminants from air **12** using a separator in the form of a vortex-generating cylinder **104** installed within a cylindrical canister **106**. A suction inlet **34'** leading tangentially into canister **106** directs air **12** into a downward circular motion around cylinder **104**. Centrifugal force separates the contaminants from air **12** by slinging the heavier contaminating particles and against the interior wall of canister **106**. A funnel **108** then directs the separated contaminants to the bottom of canister **106** for later disposal. Once the contaminants are separated from the air, the cleaner air travels up through a central portion of cylinder **104**. From there, impeller **18** forces the now cleaner air out through discharge outlet **52**.

Although the invention is described with reference to a preferred embodiment, it should be appreciated by those of ordinary skill in the art that various modifications are well within the scope of the invention. The separators of FIGS. **5** and **6**, for example, can also be used in the vacuum systems illustrated in FIG. **1**. Therefore, the scope of the invention is to be determined by reference to the following claims.

The invention claimed is:

1. A central vacuum system for reducing the pressure of air to less than that of an ambient atmosphere that contains contaminants, the system comprising:

a canister for installation at a substantially fixed location;

a divider system disposed within the canister to help define within the canister a suction chamber, a motor chamber, a plenum, and an electrical chamber;

a motor extending into the motor chamber, wherein the motor heats the air therein;

a main impeller coupled to the motor to help create a suction pressure within the suction chamber;

a secondary impeller coupled to the motor, wherein the secondary impeller forces air from the ambient atmosphere into the electrical chamber, forces air from the electrical chamber into the plenum, forces air from the plenum into the motor chamber, and forces air from the motor chamber to the ambient atmosphere; and

a motor drive component disposed within the electrical chamber and being electrically coupled to the motor, wherein the air forced through the electrical chamber helps cool the motor drive component.

2. The central vacuum system of claim **1**, wherein the air in the electrical chamber is upstream of the air in the motor chamber.

3. The central vacuum system of claim **1**, wherein the motor chamber conveys air at a greater flow rate than that of the electrical chamber.

4. The central vacuum system of claim **1**, wherein the air in the plenum is cooler than the air in the electrical chamber.

5. The central vacuum system of claim **1**, wherein the electrical chamber conveys air at an electrical chamber pressure, the plenum conveys air at a plenum pressure, the motor chamber conveys air at a motor chamber pressure, and the suction chamber conveys air at a suction pressure, wherein:

i. the motor chamber pressure is greater than the ambient atmosphere pressure,

ii. the ambient atmosphere pressure is greater than the electrical chamber pressure,

iii. the electrical chamber pressure is greater than the plenum pressure, and

iv. the plenum pressure is greater than the suction pressure.

6. The central vacuum system of claim **1**, wherein the plenum is above the electrical chamber and the motor chamber, and the suction chamber is below the electrical chamber and the motor chamber.

7. The central vacuum system of claim **1**, wherein the canister comprises a substantially cylindrical outer wall within which the electrical chamber is contained.

8. The central vacuum system of claim **7**, wherein the weight of the electrical component is carried by the substantially cylindrical outer wall.

9. The central vacuum system of claim **1**, wherein the divider system includes a first divider and a second divider, wherein the first divider separates the motor chamber from the suction chamber, and the second divider separates the plenum from the motor chamber, and the second divider defines an opening that places the plenum in fluid communication with the electrical chamber.

10. The central vacuum system of claim **9**, wherein the divider system includes a third divider extending between the first divider and the second divider.

11. The central vacuum system of claim **1**, further comprising:

a main separator interposed between the main impeller and the suction chamber to help separate the contaminants from the air that the main impeller draws from the suction chamber; and

a secondary filter interposed between the motor chamber and the ambient atmosphere, wherein the secondary filter helps filter the air passing from the motor chamber to the ambient atmosphere.

12. A central vacuum system for reducing the pressure of air to less than that of an ambient atmosphere that contains contaminants, the system comprising:

a canister that includes a tubular sidewall and an upper end cap, wherein the upper end cap defines a plenum inlet, and the tubular sidewall defines a suction inlet, an electrical chamber inlet and a motor chamber outlet;

a first divider disposed within the canister, wherein the first divider and the tubular sidewall help define a suction chamber that is in fluid communication with the ambient atmosphere via the suction inlet;

a second divider disposed within the canister and defining an electrical chamber outlet, wherein the second divider, the tubular sidewall and the upper end cap help define a plenum that is in fluid communication with the ambient atmosphere via the plenum inlet;

a third divider disposed within the canister and extending between the first divider and the second divider, wherein first divider, the second divider, the third divider and the sidewall help define a motor chamber and an electrical chamber, wherein the motor chamber is in fluid communication with the ambient atmosphere via the motor chamber outlet, the motor chamber is in fluid communication with the plenum, and the electrical chamber is in fluid communication with the ambient atmosphere via the electrical chamber inlet;

a motor extending into the motor chamber, wherein the motor heats the air therein;

a main impeller coupled to the motor to help create a suction pressure within the suction chamber;

a motor drive component disposed within the electrical chamber and being electrically coupled to the motor, wherein the motor drive component heats the air within the electrical chamber; and

a secondary impeller coupled to the motor, wherein the secondary impeller:

i. forces air from the ambient atmosphere into the electrical chamber via the electrical chamber inlet,

ii. forces air from the electrical chamber into the plenum via the electrical chamber outlet,

iii. forces air from the ambient atmosphere into the plenum via the plenum inlet,

iv. forces air from the plenum into the motor chamber, and

v. forces air from the motor chamber to the ambient atmosphere via the motor chamber outlet.

13. The central vacuum system of claim **12**, wherein the motor chamber conveys air at a greater flow rate than that of the electrical chamber.

14. The central vacuum system of claim **12**, wherein the air in the plenum is cooler than the air in the electrical chamber.

15. The central vacuum system of claim **12**, wherein the electrical chamber conveys air at an electrical chamber pressure, the plenum conveys air at a plenum pressure, the motor chamber conveys air at a motor chamber pressure, and the suction chamber conveys air at a suction pressure, wherein:

i. the motor chamber pressure is greater than the ambient atmosphere pressure,

ii. the ambient atmosphere pressure is greater than the electrical chamber pressure,

iii. the electrical chamber pressure is greater than the plenum pressure, and

iv. the plenum pressure is greater than the suction pressure.

16. The central vacuum system of claim **12**, wherein the plenum is above the electrical chamber and the motor chamber, and the suction chamber is below the electrical chamber and the motor chamber.

17. The central vacuum system of claim **12**, further comprising:

a main separator interposed between the main impeller and the suction chamber to help separate the contaminants from the air that the main impeller draws from the suction chamber; and

a secondary filter interposed between the motor chamber and the ambient atmosphere, wherein the secondary filter helps filter the air passing from the motor chamber to the ambient atmosphere.

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